

# Risk Estimate Distances for Indirect Fires in Combat

by Major Gerard Pokorski and Lonnie R. Minton

**“Take calculated risks. That is quite different from being rash.”**



*General George Smith Patton, Jr. in a letter to  
Cadet George S. Patton IV, 6 June 1944*

**R**isk is inherent in war. At times, a commander must put his soldiers in harm's way to accomplish the mission. A combatant who is unwilling to put himself and his soldiers at necessary risk is doomed to defeat—regardless of other advantages.

The current climate in the armed forces has made us averse to risk, and rightfully so in a peacetime environment. But even in peacetime, most maneuver commanders realize that, in combat, they won't use the same measures they employ in live-fire training exercises to ensure the complete safety of the force. This is especially true for indirect fires.

Each new generation of infantry commanders asks its fire supporters the same question: “If I'm assaulting an objective, how close can my troops get before I have to turn off the mortars and artillery?” Good question.

This article discusses the difference between risk estimate distances and minimum safe distances (MSDs) and presents a table of the former to help the commander determine the level of risk he'll accept for covering his assaulting soldiers with indirect fires.

## Current Sources of Safety Data

Using the guidelines in “Army Regulation 385-63 Policies and Procedures for Firing Ammunition for Training, Practice and Combat” or the MSD table in the recently rescinded manual *FM 6-*

*141-1 Field Artillery Target Analysis and Weapons Employment: Nonnuclear (U)*, we derive an MSD of approximately 350 meters for 105-mm rounds and 300 meters for 60-mm rounds with a 99 percent assurance that the damage radius will not extend to friendly positions. However, no dismounted soldier wants to assault the last 300 meters without indirect fires providing at least suppression on the objective.

History gives us many examples of soldiers intentionally calling in artillery less than 50 meters from their positions and surviving. The Battle of the Ia Drang Valley in Vietnam quickly comes to mind. Such examples lead fire supporters and infantrymen alike to be skeptical of MSDs' delineation of how close soldiers can come to friendly indirect fire.

Although the title of AR 385-63 includes the word “combat,” the regulation clearly applies to training. Paragraph 1-1, “Purpose,” states, “This regulation prescribes general safety precautions necessary to minimize the possibility of accidents in the firing and other uses of ammunition and explosives by troops in training...and *as much as possible* [emphasis added], combat and range operations, including range clearance.” No other guidance is given in the manual for combat conditions.

An example of the training focus of the regulation is in Paragraph 10-1 that states firing mortars over unprotected troops is prohibited, except for troops in tanks located 100 meters or more from the line of fire. No caveat is given for combat. (An updated AR 385-63 soon

will replace the AR but will be titled more accurately “Range Safety.”)

Thus, many infantrymen and fire supporters see our MSDs as a peacetime training safety standard or, at least, a distance in combat in which there is virtually no risk to friendly casualties. A common refrain from the infantryman after the MSD is cited is, “If I'm willing to accept some risk, how close can I *really* get?”

For years, the Army has been publishing risk estimate distance tables (sometimes misnamed as MSD tables) for aerial-delivered munitions in its 6, 7 and 71-series field manuals. Figure 1 shows that the risk estimate distance for a MK 82 high-drag 500-pound bomb with personnel in prone position is 375 meters for a one-in-one-thousand probability of incapacitation (PI). However, the danger area in AR 385-63 for an 81-mm mortar is 350 to 400 meters. Comparing the two, it stands to reason that, in combat, we should be able to get closer than 350 meters from an 81-mm mortar round with acceptable risk.

## Risk Estimate Distances for Indirect Fires

At the request of a live-fire observer/controller at the Joint Readiness Training Center, (JRTC), Fort Polk, Louisiana, we developed a table for indirect fire assets in the close fight (see Figure 2 on Page 10). We used the models and programs used to compute the aerial ordnance data in Figure 1.

The intent of the risk estimate distances table is not to be a safety guide that accounts for all possible variations in indirect fire weapons. The intent is to enable the combat commander to make informed decisions on the risk from friendly fire support when his troops assault an enemy position. Each commander can determine the amount of risk he's willing to accept based on the cover available, experience and posture of his troops, and accuracy and proficiency of the firing units. In essence, the table tells him that if the rounds land where they're supposed to, “this” is the risk based on the conditions outlined. He then analyzes his combat situation and acts accordingly.

The risk estimate table should not be seen as a restrictive document whereby the distances become new standards that commanders must not violate in combat. If the mission dictates, com-

WEAPON	DESCRIPTION	MINIMUM SAFE DISTANCE	
		(10% PI)	(0.1% PI)
MK 82 LD	500-pound bomb	250m	425m
MK 82 HD	500-pound bomb	100m	375m
MK 82 LGB	500-pound bomb (GBU-12)	*	*
MK 83 HD	1,000-pound bomb	275m	500m
MK 83 LD	1,000-pound bomb	275m	500m
MK 83 LGB	1,000-pound bomb (GBU-16)	275m	500m
MK 84 LD	2,000-pound bomb	225m	500m
MK 84 LGB	2,000-pound bomb (GBU 10-22)	*	*
MK20 **	ROCKEYE CBU (antiarmor)	*	*
2.75 FFAR	Rockets (various warheads)	100m	175m
SUU-11	7.62mm mini-gun	*	*
M-4/M-12/SUU-23/M-61	20mm Gatling gun	*	*
GAU-12	25mm Gatling gun	*	*
GPU-5A/GAU-8A	30mm Gatling gun	*	*
AGM-65 (AF)	Maverick missile (TV/IR/laser)	*	*
MK 21/29	WALLEYE I 1,000-pound bomb (TV guided)	275m	500m
MK 23/30	WALLEYE II 2,400-pound bomb (TV guided)	*	*
AGM-123A	SKIPPER 100-pound bomb (laser guided; rocket boosted)	275m	500m

\* Minimum safe distances have not been determined.

\*\* Not recommended for use near friendly troops.

PI - probability of incapacitation; LD - low drag; HD - high drag; LGB - laser guided bomb; FFAR - folding fin aircraft rocket; GBU - guided bomb unit.

Figure 1: "Close Air Support (CAS) Ordnance Reference Data" from *FM 71-123 Tactics and Techniques for Combined Arms Heavy Forces: Armored Brigade, Battalion/Task Force, and Company/Team* (Table 7-2 on Page 7-12)

manders can and should call in indirect fires much closer to their troops than the distances listed in the table. (See FM 6-141-1, Paragraph 4-15.) Because this table gives risk estimates for personnel assaulting (standing), the combat commander can reduce the risk of bringing fires closer than the table's distances by using the smallest caliber weapon system and positioning personnel prone and (or) behind cover.

Note that the risk estimate distances *do not* represent the maximum fragmentation envelopes of the weapons listed.

## Distance Computations

The distances in the table allow the commander to estimate the risk in terms of the percent of friendly casualties that may result from an indirect fire attack against the enemy. The distances are based on fragmentation patterns.

Note that risk estimate distances are for combat use and *are not* MSDs for peacetime training. See the Joint Muni-

tions Effectiveness Manuals (JMEMs), appropriate service or command guidance for peacetime or combat restrictions.

The data in Figure 2 are derived from *FM 101-62-1 JMEM, Fragmenting Munitions: Safe Distances and Assessment of Risk to Friendly Troops* (U) and the accuracy of the systems. The data is based on all attacks being perpendicular to the forward line of own troops (FLOT). Distances are determined from the intended mean point of impact (MPI) using an aiming policy appropriate for the systems. Probable errors for the systems (precision and MPI errors) are included in the risk estimate distance.

**Assumptions.** The distances assume that the firing unit has had its fires adjusted onto the target by an observer. For all determinations in Figure 2, the soldier was assumed to be standing (posture closest in the model to assaulting), in open terrain and on a line perpendicular to the line of fire.

**Casualty Criterion.** The casualty criterion is the serious-wound/lethal-wound criterion for a standing soldier in winter clothing and helmet. The PI for

this criterion means the soldier is required to be evacuated from the battlefield. A PI value of less than 0.1 percent means the soldier has less than or equal to one chance in one thousand of sustaining injuries requiring evacuation.

**Troops in Contact.** Unless the ground commander determines otherwise, the fire support officer should regard friendlies within one kilometer of targets as "troops in contact" and advise the ground commander accordingly. Note that friendlies outside the 0.1 percent PI distance and MSD may *still* be subject to weapons fragments. Commanders and fire supporters must carefully weigh the choice of ordnance and the accuracy and proficiency of the firing unit in relation to the risk of fratricide.

Ground commanders must accept responsibility for the risk to friendly forces when targets are inside the surface danger zone parameters set forth in AR 385-63. When they approve the delivery of ordnance, they accept the risk inherent in those zone parameters.

With the risk estimate distances table, commanders can make informed deci-

• **Warning:** Risk Estimate Distances are for combat use and are not minimum safe distances for peacetime training. See the Joint Munitions Effects Manuals (JMEMS), appropriate service or command guidance ("Army Regulation 385-63 Range Safety" or FM 90-20/FMFRP 2-72 *Multiservice Procedures for Joint Application of Firepower*) for peacetime and combat safety restrictions.

• **Warning:** Risk Estimate Distances do not represent the maximum fragmentation envelopes of the weapons listed.

• **Basis of Calculations:** The distances were calculated based on data for troops standing (e.g., assaulting) in winter uniform with helmet (no fragmentation vest) on open terrain. This chart assumes the firing unit has had its fires adjusted onto the target by an observer.

Caliber	# of Guns	System	Shell/Fuze	10% PI (Radius in Meters)			0.1% PI (Radius in Meters)		
				1/3 System Range	2/3 System Range	Max Range	1/3 System Range	2/3 System Range	Max Range
60-mm	3*	M224	HE/PD or VT	60	65	65	100	150	175
81-mm	3*	M29 M29A1	HE/PD or VT	75	80	80	165	185	230
105-mm	4*	M119 M102	HE/PD or VT	85	85	90	175	200	275
155-mm	4	M109 M198	HE/PD or VT	100	100	125	200	280	450
155-mm	4	M109 M198	DPICM	150	180	200	280	300	475
203-mm	4	M110	HE/PD or VT	195	235	275	365	390	520
5-Inch/38-mm*	1 Gun, Multiple Rounds	5"/38	HE/PD or VT	210	225	250	450	450	600
5-Inch/54-mm*	1 Gun, Multiple Rounds	5"/54	HE/PD or VT	210	225	250	450	450	600

\*Current limitations in the model require computations for the number of weapons indicated although the number differs from the number of weapons in actual firing units.

\*Naval surface gunfire's relatively flat trajectory results in a large range probable error. The dispersion pattern of the naval gun is roughly elliptical with the long axis in the direction of fire. The gun-target line and its relation to the forward line of own troops (FLOT) must be considered by the fire support officer (FSO) in selecting naval gunfire as a fire support means. Because of the movements of the ship while firing, the gun-target line may change. Friendly units should avoid the gun-target line. If possible, the gun-target line should be parallel to the FLOT.

#### Legend:

**HE:** High Explosive

**DPICM:** Dual-Purpose Improved Conventional Munition

**PI:** Probability of Incapacitation (This means a soldier is required to be evacuated from the battlefield. A PI value of less than 0.1% can be interpreted as being less than or equal to one chance in 1,000 of requiring evacuation.)

**PD:** Point-Detonating Fuze

**VT:** Variable-Time Fuze



will accept from friendly indirect fires to accomplish the mission.

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Figure 2: Risk Estimate Distances for Observed Fires

sions regarding when to shift friendly indirect fires during an assault. Instead of knowing only the limit of total safety, they can balance risks with indirect fire effectiveness to get the assault force as close as possible to its objective before the battle becomes strictly a direct fire contest.

It has been many years since the United States has been involved in a protracted conflict against a foe determined to overcome our technological advantage by "hugging our belt" and bringing the fight in close. Regardless of technologies, the close fight will always be with us.

The risk estimate distances table will help commanders determine the risk they